What is claimed:

1.

Sub A'

A method of monitoring drying of a batch of an agricultural porous media such as a mass or collection of grain or seed comprising:

(a) deriving a moisture content of the porous media by time domain reflectometry;

(b) utilizing the value to monitor drying of the porous media.

2.

The method of claim 1 further comprising monitoring drying rate of the media.

3.

The method of claim 1 further comprising monitoring moisture content of the media and comparing moisture content to an end point moisture content.

4.

The method of claim 3 further comprising generating a signal when the end point moisture content is reached.

5.

The method of claim 1 wherein the porous media is selected from the set comprising grain and seed, whether or not separated from a carrier or other vegetative structure.

6.

The method of claim 5 wherein the porous media is seed.

7.

The method of claim 6 wherein the seed is corn.

8.

The method of claim 7 wherein the corn is ear corn.

9.

The method of claim 7 wherein the corn is shelled corn.

10.

The method of claim 6 wherein the seed is sunflower seed.

11.

The method of claim 1 further comprising utilizing the derived moisture content to control an artificial drying process.

12.

The method of claim 1 further comprising deriving moisture content at a plurality of locations in the porous media.

13.

The method of claim 12 wherein the plurality of locations are at different vertical heights.

14.

The method of claim 12 further comprising utilizing the derived moisture contents to control an artificial drying process.

15.

The method of claim 1 wherein the step of deriving moisture content comprising obtaining a TDR measurement via a probe at least substantially surrounded by the porous media and comparing the TDR measurement to a calibration data set.

16.

The method of claim 1 further comprising positioning an electrically conducting probe of a length L in the bin so that the porous media at least substantially surrounds the probe; creating an impedance mismatch at the point of electrical connection of the probe to a cable; sending a step function voltage pulse through the cable, the impedance mismatch, and the probe; measuring the reflection of the pulse.

17.

The method of claim 16 wherein the step function is a non-shorted step pulse.

18.

The method of claim 16 wherein the pulse is generated and communicated to each probe.

19.

The method of claim 16 wherein the impedance mismatch is ideal.

20.

The method of claim 16 wherein the impedance mismatch is created by operatively placing a capacitor in the path of pulse.

21.

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The method of claim 16 wherein the impedance mismatch is created by crimping an electrical conduit for the pulse.

22.

The method of claim 1 further comprising measuring moisture content and monitoring drying in a plurality of dryer bins.

23.

The method of claim 1 wherein the moisture content is derived at successive times during drying.

24.

The method of claim 23 wherein the successive times are spaced intervals of time.

25.

The method of claim 1 wherein the moisture content is derived interiorly of the mass or collection of porous media.

26.

The method of claim 25 wherein the moisture content is derived across a substantial portion of the porous media.

27.

A method for monitoring moisture content of an agricultural product such as grain or seed during an artificial drying process comprising:

(a) placing the product to be dried into a bin;

(b) positioning an electrically conducting wave guide of known length in the product;

(c) sending an electromagnetic pulse through the wave guide;

(d) deriving amount of time for said pulse to move end to end through the wave guide by time domain reflectometry; and

(e) deriving moisture content of the product around the wave guide from the time domain reflectometry derived time.

28.

The method of claim 27 further comprising placing a plurality of wave guides of known length into the product.

29.

The method of claim 27 further comprising utilizing the moisture content derived by time domain reflectometry to control the drying process.

30.

The method of claim 29 wherein the control of the drying process comprises utilizing measured moisture content derived by time domain reflectometry in the control of airflow and/or air temperature through the product.

31.

The method of claim 27 wherein the agricultural product is grain or seed whether or not on a carrier and the moisture content of the grain or seed is derived by compensating for moisture in the carrier, if any.

32.

An apparatus for monitoring artificial drying of an agricultural porous media such as grain or seed comprising;

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(a) a drying chamber for holding a porous media to be dried;

(b) a time domain reflectometry wave guide adapted for insertion into a porous media in the drying chamber;

(c) a time domain reflectometry device;

(d) an electrical connection between the wave guide and the time domain reflectometry device;

(e) the time domain reflectometry device adapted to derive moisture content of the porous media from time domain reflectometry signals which travel through the wave guide, and make derived moisture content available for use in monitoring or controlling the drying process.

33.

The apparatus of claim 32 wherein the porous media comprises ear corn.

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34.

The apparatus of claim 33 wherein the drying chamber is a bin at least several feet by several feet in size.

35.

The apparatus of claim 32 wherein the wave guide comprises an electrically conducting rod of a certain length.

36.

The apparatus of claim 35 wherein the wave guide comprises an array of electrically conducting rods spaced apart from one another and connected to a header.

37.

The apparatus of claim 32 wherein the TDR device comprises a step voltage pulse generator and digital sampler, the step voltage generator connected by an electrical cable to the electrical connection, the digital sampler electrically connected to the electrical connection.

38.

The apparatus of claim 32 further comprising a dryer controller operatively connected to the time domain

reflectometry device, the dryer controller including a processor adapted to receive a signal from the TDR device and utilize it to generate instructions adapted for a drying system for controlling airflow and/or temperature to the bin.

39.

The apparatus of claim 38 further comprising an interface between the wave guide and the TDR device, the interface comprising a multiplexer.

40.

The apparatus of claim 32 further comprising a component to introduce an impedance mismatch prior to the wave guide.

41.

The apparatus of claim 40 wherein the component to introduce an impedance mismatch comprises a capacitor.

42.

The apparatus of claim 40 wherein the component to introduce an impedance mismatch is created by placing a crimp in the electrical connection at or very near its connection to the wave guide.

A1 Cont

43.

An apparatus to monitor moisture content of an agricultural product such as grain or seed to assist in control of artificial drying of the product comprising:

(a) a dryer bin;
(b) a TDR probe positioned in the bin;
(c) an electromagnetic energy source adapted to create an electromagnetic pulse to travel through the probe;
(d) an electromagnetic reflection sensor;
(e) an electrical interface between the probe and the energy source and the reflection sensor;
(f) an electromagnetic reflection analyzer electrically interfaced with the electromagnetic reflection sensor;

(g) so that time domain reflectometry information can be derived for the pulse relative to the probe.

44.

The apparatus of claim 43 wherein the probe comprises an elongated electrically conducting wave guide.

45.

The apparatus of claim 44 further comprising a plurality of probes.

46.

The apparatus of claim 43 wherein the electromagnetic energy source is a step voltage generator.

47.

The apparatus of claim 43 wherein the electromagnetic reflection sensor is a digital sampler.

A1 Con't

48.

The apparatus of claim 43 wherein the electrical interface comprises a multiplexer.

49.

The apparatus of claim 43 wherein the electromagnetic reflection analyzer is a processor.

50.

The apparatus of claim 49 wherein the processor includes software for evaluating the output of the reflection sensor and deriving moisture content of the product surrounding each probe related to a point in time.

51.

The apparatus of claim 50 further comprising a connection between the processor and a dryer controller so that artificial drying can be controlled by instructing the dryer controller as a function of moisture content readings.

52.

The apparatus of claim 43 further comprising a plurality of probes for a plurality of dryer bins, each probe

operatively connected to the electromagnetic source and reflection sensor, for monitoring moisture in a plurality of locations simultaneously or sequentially.

~~54~~. 53

The apparatus of claim 52 further comprising operatively connecting the reflection sensor to a processor having an interface with a control unit for controlling operation of a dryer.

~~55~~. 54

The apparatus of claim 54 wherein the probe comprises three electrically conducting members, generally parallelly spaced apart.

~~56~~. 55

The apparatus of claim 55 wherein the middle member is connected to the electromagnetic energy source and the outer members to ground.

A1 Cont

~~57~~. 56

The apparatus of claim 55 further comprising a plurality of members, generally parallel to one another, successive members alternating between connection to the electromagnetic energy source and ground respectively, except for the outer two members which are connected to ground.

~~58~~. 57

The apparatus of claim 54 wherein the probe is in the range of 4 feet to 16 feet long.

~~59~~. 58

The apparatus of claim 54 wherein the probe is comprised of tubes approximately 2 inches in diameter.

~~60~~. 59

The apparatus of claim 54 wherein the probe extends substantially across the bin.

60

61.

The apparatus of claim 60 further comprising supports to attach and hold the probe relative to the bin.

~~62.~~ 61

A probe for use with a TDR system for monitoring artificial drying of an agriculture product such as seed or grains in a dryer bin or chamber of over 50 cubic feet in volume, comprising:

(a) an elongated electrically conductive member sized to extend a substantial distance into a material to be measured in the bin or chamber;

(b) a connection to an electrical conduit adapted for connection to a TDR device;

(c) an impedance mismatch component in the electrical conduit;

(d) a support connection adapted to connect the conductive member to supporting structure associated with the bin or chamber.

~~63.~~ 62

The apparatus of claim 62 wherein the electrically conductive member comprises a waveguide array of three elongated electrically conductive members adapted to be generally parallelly spaced apart in position in a bin or chamber, the center member adapted to be in electrical communication with a fast rising stepped electromagnetic pulse via the conduit, the outer members adapted to be connected to ground.

64. 63

The apparatus of claim 63 wherein each member is in the range of 4 to 16 feet long.